Readmissions for Selected Infections Due to Medical Care: Expanding the Definition of a Patient Safety Indicator

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Abstract

Objective: Evaluate the Agency for Healthcare Research and Quality's Patient Safety Indicator that identifies patients with selected infections that result from medical care during hospital inpatient treatment (secondary diagnosis of selected infection/infection not present at admission). **Method**: Using unique patient identifiers in New York inpatient hospitalization data, patients identified with a principal diagnosis of a selected infection (present at admission) were linked to any antecedent inpatient discharge. **Results**: Many patients with a principal diagnosis of selected infection (present at admission) were linked to a previous recent inpatient encounter. The hospital-level estimate of cases of selected infection resulting from inpatient treatment (secondary diagnosis of selected infection) increased 25 percent when patients identified with a principal diagnosis of selected infection were linked to antecedent inpatient discharges. **Conclusions**: The hospital-level estimate of cases of selected infection is an underestimate of infections resulting from inpatient treatment.

Introduction

Awareness by researchers and health policymakers of medical errors and their consequences has been heightened since the publication of the Institute of Medicine's (IOM) report, *To Err Is Human: Building a Safer Health System.*[1] The Agency for Healthcare Research and Quality (AHRQ) has accelerated efforts to address the problems raised by this report by improving the identification of medical errors. As a part of its response, AHRQ has developed a set of quality indicators designed to evaluate health care delivered in inpatient and ambulatory care settings. Complications of care and adverse events occurring in the inpatient hospital setting that may be related to quality of care problems are captured by AHRQ's Patient Safety Indicators (PSIs).[2, 3]

The PSIs are a set of measures that identify problems that patients experience as a result of contact with the health care system—problems that are likely preventable by changes at the system or provider level.[4] The PSIs have been defined using only the type of information found in inpatient hospital discharge abstract data; the specific data elements required by the PSI algorithms are available from most hospital and State-level inpatient administrative data systems. PSIs are defined at the hospital level and the area level:

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- Hospital-level indicators identify potentially preventable complications that arose while patients were hospitalized for their initial care. Secondary diagnosis codes (condition not present at admission) are used to identify patients with the hospital-level indicators.
- Area-level indicators identify all cases of the potentially preventable complications that occur in a given geographic area (e.g., metropolitan service area or county); they include complications that arose during hospitalization or that resulted in a subsequent hospitalization. The principal diagnosis (condition present at admission), as well as secondary diagnoses, are used to define the area-level indicators. The area-level definition adds cases where a patient's risk of the complication occurred in a separate encounter with the health care system (inpatient or outpatient).

AHRQ developed the hospital-level PSIs to capture inpatient events that occur during a single admission, recognizing that many State administrative databases do not have the capability of tracking patients across multiple admissions. One flaw in using is the possibility of underestimating the prevalence of some of the PSIs attributable to inpatient care: adverse events that occur shortly after discharge and result in readmission are not captured in hospital-level PSIs. This study uses only data from a New York hospital discharge administrative database, which is capable of tracking patients across multiple admissions. These data help estimate the volume of those adverse events that occur in the admission during which an intravascular device is inserted, but are not captured when reporting only the hospital-level PSI Selected Infections Due to Medical Care. By attributing area-level PSI cases that occur because of inpatient care to the hospital-level PSI, the sensitivity of the hospital-level PSI can be increased. This study also examines the characteristics of these readmitted patients relative to patients who suffer from Selected Infections Due to Medical Care in the initial admission. Finally, we examine the number of cases and characteristics of patients captured by the hospital-level and the area-level PSI, and the resulting readmissions to evaluate the relative contribution of events from various health care settings.

Methods

Data source

This is a descriptive study, based on New York's 2001 inpatient discharge database, the Statewide Planning and Research Cooperative System (SPARCS). SPARCS contains demographic, diagnostic, procedural, and expenditure information on each person discharged from a nonfederal acute care hospital in New York. Hospitals are required to submit data abstracted from medical records along with billing information to the New York State Department of Health,

which is responsible for overseeing the data and ensuring the accuracy of the information.

Case definitions and analyses

Identification of Selected Infections Due to Medical Care cases

The AHRQ PSI programs (Version 2.1, Revision 1, May 2003),[3] contain modules that define denominator and numerator events, calculate overall observed rates; and calculate risk-adjusted rates of hospital- and area-level patient safety events. The PSI algorithm for Selected Infections Due to Medical Care was applied to data from the New York State inpatient hospitalization administrative data system for discharges in 2001. The hospital-level algorithm defines cases as surgical or medical discharges with International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes for Selected Infections Due to Medical Care in any secondary diagnosis field, and these same codes in any diagnosis field are used for the area-level indicator.

The Selected Infections Due to Medical Care hospital-level PSI was developed to capture adverse events that occurred in-hospital and, thus, represented potentially preventable complications of care rather than pre-existing comorbidities. Therefore, the algorithm applies to patients with a secondary diagnosis of Selected Infections Due to Medical Care who appear to have acquired the infection after admission. It excludes patients with a diagnosis of cancer or an immunocompromised state, who are at an increased risk of infection. The area-level PSI captures all occurrences of infection due to medical care, regardless of the setting of care, and is comprised of three groups of patients: patients identified with a secondary diagnosis of selected infection (the hospital-level indicator definition); patients who have a primary diagnosis of selected infection as a result of inpatient care; and patients who have a primary diagnosis of selected infection as a result of outpatient care are all captured by the area indicator. The specific ICD-9-CM codes and surgical Diagnostic Related Groups (DRGs) used in the algorithm are available from AHRQ.[2, 3]

The hospital-level PSI includes cases that have selected infections due to medical care diagnosis codes in the principal diagnosis position. This occurs when a patient has a primary and secondary diagnosis code for selected infections due to medical care in the same record. Because the intent of the hospital-level indicator is to identify cases that occur after admission, these cases were eliminated from the hospital-level PSI for this analysis.

Identification of readmits with a principal diagnosis of selected infections due to medical care

New York State hospital discharge data contains data elements that allow for tracking patients across hospital stays, including unique patient identifiers, medical record numbers, hospital identifiers, and patient dates of birth. We used these data elements to identify patients readmitted to the hospital with a principal diagnosis of Selected Infections Due to Medical Care within 30 days of a prior

hospitalization. If a patient had a principal diagnosis of Selected Infections Due to Medical Care during the readmission and also had a principal or secondary diagnosis of Selected Infections Due to Medical Care in the initial admission, they were excluded. Because New York State inpatient discharge data contains unique patient identifiers, we were able to capture patients who were readmitted to the same hospital as the index admission and patients who were readmitted to a different hospital. We also included the small number of cases (n = 50) originally admitted during December 2000 and readmitted during January 2001.

Analytic approach

Calculation of counts and rates

The rate of Selected Infections Due to Medical Care that occurred in New York during 2001 was identified by determining the number of cases meeting the AHRQ hospital-level PSI algorithm, per 1,000 discharges meeting the PSI definition of an at-risk patient. We next determined the total number of readmissions within 30 days with a primary diagnosis of Selected Infections Due to Medical Care and the rate per 1,000 index admissions. Finally, counts and rates of patients identified with the area-level PSI were calculated.

Mortality

Mortality was measured as the percentage of patients identified with the Selected Infections Due to Medical Care PSI who died during initial admission, and the percentage of patients readmitted within 30 days who died during readmission.

Morbidity

Morbidity was measured as the percentage of cases experiencing complications of infection during initial admission, for patients meeting the AHRQ hospital-level definition, and during readmission for those readmitted within 30 days. Rates of complications that appear to be directly related to intravenous line and catheter infections, including local site infection as evidenced by a secondary diagnosis of cellulites, were calculated. Rates of more serious intravenous line and catheter related infections, including septicemia and bacteremia, were also ascertained.

Demographics

Differences in demographics (age, sex, race) between patients meeting the AHRQ definition and patients readmitted within 30 days with Selected Infections Due to Medical Care were examined. Differences were tested for statistical significance using chi-square tests with $P < 0.05$ regarded as statistical significance.

Patient type

Differences in major types of patients (renal dialysis patients versus others) will be presented for in-hospital events, readmissions, and events captured by the area-level PSI.

Results

Table 1 shows that slightly more than 77 percent (n = 1,908,568) of the 2,478,204 discharges included in the 2001 SPARCS database met the AHRQ definition for a medical or surgical case. Of these cases, 3,858 (0.202 percent) had a secondary diagnosis code for Selected Infections Due to Medical Care. The number of cases readmitted to a hospital within 30 days with a principal diagnosis of Infection Due to Medical Care was 950, which was 0.05 percent of all index admissions meeting the AHRQ definition of a Selected Infection Due to Medical Care. Table 1 also shows the number of events identified with the area-level PSI (7,373).

Table 1. Numbers and rates of AHRQ Infection Due to Medical Care cases and patients readmitted within 30 days, among New York discharges, 2001

	N	Rate (%)
Total discharges	2,478,204	-
Eligible hospital-level risk pool	1,908,568	77.0
AHRQ Infection Due to Medical Care cases (hospital)	3,858	0.202
Total readmissions within 30 days (all causes)	425,359	
Readmissions within 30 days with primary diagnosis of Infection Due to Medical Care	950	0.050
Eligible area-level risk pool	19,011,378	-
AHRQ Infection Due to Medical Care cases (area)	7,373	0.0387

Our examination of patients identified by the PSI revealed that many were renal dialysis patients. The ICD-9-CM codes that were used to identify renal dialysis patients are listed in Appendix 1.* Table 2 presents the distribution of renal dialysis patients in the hospital-level PSI, outpatients (captured by the area-level PSI), and readmission patient groups. Approximately 25 percent of the patients captured by the hospital-level PSI had an indication of renal or peritoneal dialysis. For patients identified as readmissions after a previous inpatient stay, 55.6 percent were renal or peritoneal dialysis patients. A total of 64.7 percent of the patients identified by the area-level PSI who were not in the hospital-level PSI or readmission groups (principal diagnosis of Selected Infections Due to Medical

* The appendix cited in this report is available from the corresponding author.

Table 2. Comparison of renal dialysis patients among hospital-level PSI patients, area-level PSI patients, and readmitted patients

		Renal dialysis		No renal dialysis	
	N	n	%	n	%
Hospital-level PSI patients	3,858	990	25.7	2,868	74.3
Readmits*	950	528	55.6	422	44.4
Outpatients**	2,611	1,690	64.7	921	35.3

* Readmits: cases readmitted to the hospital with a principal diagnosis of Selected Infection Due to Medical Care within 30 days of a prior hospitalization.
** Outpatients: cases meeting the area-level criteria but not in the hospital-level PSI patients or readmits group.

Care) and appeared to be admitted to the inpatient setting from an outpatient setting had an indication of renal or peritoneal dialysis.

Table 3 indicates that mortality for hospital-level PSI patients was 15.7 percent, patients readmitted within 30 days with a primary diagnosis of Infection Due to Medical Care had a 6.3 percent rate, and hospital-level PSI patients combined with patients readmitted within 30 days with a primary diagnosis of Infection Due to Medical Care had an 11 percent rate. The mortality rate of patients identified with the hospital-level PSI combined with the readmitted patients is 29.9 percent lower then the mortality rate of the hospital-level PSI patients alone. Local site infection as measured by a secondary diagnosis of cellulitis was present in 15 percent of the patients captured by the hospital level PSI, in 13.2 percent of patients readmitted for Selected Infections Due to Medical Care, and in 14.1 percent of hospital-level PSI patients combined with readmitted patients. More serious intravenous line and catheter-related infections, as measured by a secondary diagnosis of septicemia, occurred in 35.5 percent of the hospital-level PSI patients, in 39.2 percent of the patients readmitted for Selected Infections Due to Medical Care, and in 37.4 percent of hospital-level patients combined with readmitted patients. The rate of septicemia in hospital-level patients combined with readmitted patients was 5.2 percent higher then in hospital-level patients alone. Rates of bacteremia in the hospital-level PSI patients (12 percent), readmitted patients (11.8 percent), and hospital-level combined with readmitted patients (11.9 percent) were very similar.

Table 4 indicates that the percentage of readmissions for Selected Infections Due to Medical Care who were male (48.6 percent) is very similar to the percentage of AHRQ Selected Infections Due to Medical Care patients who were male (47.7 percent) ($P = 0.62$). Also, whereas 58.3 percent of AHRQ Selected Infections Due to Medical Care patients were white, this percentage dropped to 49.1 percent among patients readmitted for Selected Infections Due to Medical Care ($P < 0.0001$). There was a tendency for the Selected Infections Due to Medical Care cases to be older then readmitted patients. A total of 21.2 percent of PSI patients were 70 to 80 years old, compared to 17.8 percent for the readmitted patients in this age group ($P < 0.0001$).

Table 3. Mortality rates and morbidity for Infection Due to Medical Care patients, patients readmitted within 30 days

	Infection Due to Medical Care Patients (n = 8,358) % or median	Patients readmitted within 30 days (n = 950) % or median	Infection Due to Medical Care patients and patients readmitted within 30 days (n = 4,808) % or median	Change with inclusion of patients readmitted within 30 days* %
Mortality	15.7	6.3	11.0	-29.9†
Cellulitis	15.0	13.2	14.1	-6.0
Septicemia	35.5	39.2	37.4	+5.2†
Bacteremia	12.0	11.8	11.9	-0.8

*Percent change in mortality/morbidity between Infection Due to Medical Care patients and Infection Due to Medical Care patients combined with patients readmitted within 30 days
+ percent increase; - percent decrease.
† The difference between the Infection Due to Medical Care patients and Infection Due to Medical Care patients combined with patients readmitted within 30 days groups was significant.

Table 4. Distributions of sex, race and age among Infection Due to Medical Care patients and patients readmitted within 30 days

		Infection Due to Medical Care Patients (n = 8,358)		Patients readmitted within 30 days (n = 950)		Infection Due to Medical Care patients compared to patients readmitted within 30 days
		n	%	n	%	*P*-value
Sex						0.6241
	Male	1842	47.7	462	48.6	
	Female	2016	52.3	488	51.4	
Race/Ethnicity						<0.0001
	White	2250	58.3	466	49.1	
	Black	777	20.1	263	27.7	
	Hispanic	299	7.8	89	9.4	
	Asian/Pacific	43	1.1	20	2.1	
	Native American	9	0.2	2	0.2	
	Other	480	12.4	110	11.6	
Age						<0.0001
	0–20	204	5.3	52	5.5	
	20–30	198	5.1	54	5.7	
	30–40	292	7.6	75	7.9	
	40–50	432	11.2	130	13.7	
	50–60	556	14.4	169	17.8	
	60–70	671	17.4	193	20.3	
	70–80	817	21.2	169	17.8	
	80 +	688	17.8	108	11.4	

Discussion

The Patient Safety Indicators, like the Complication Screening Programs and other algorithms designed to be used with hospital discharge data, are a valuable tool for measuring the potential burden associated with medical errors. The selection of events defined by the PSIs are also unique in that they all have readily available techniques to help prevent these complications. In the case of inserting an intravascular device, the appropriate technique has recently been defined to include (1) inserting intravascular device in the subclavian vein; (2) using maximum barrier protection during all intravascular device insertions; (3) using chlorhexidine-based products to clean the insertion site; and (4) using antimicrobial-treated intravascular devices in select patient groups.[5]

The focus of this study, the PSI for Selected Infections Due to Medical Care, identifies infections related to catheters and intravenous lines. Infections due to intravascular devices can lead to local site infection, catheter-related blood stream infection, septic thrombophlebitis, endocarditis, and other metastatic infections; they have been associated with increased attributable mortality.[6] Critically ill patients are at significant risk of nosocomial bloodstream infection.[7, 8] Most bloodstream infections are related to a primary infection, the majority of which originate from intravascular devices.[9–12] Intravascular device-associated bloodstream infections increase the length of stay of patients and the cost of health care.[13–15] Patients in the intensive care unit setting are at increased risk of acquiring bloodstream infections, and it has been estimated that 80,000 intravenous device-related bloodstream infections occur annually in the intensive care unit.[16, 17] If the entire hospital setting is examined, the estimate of intravascular device-related bloodstream infections increases to 250,000 annually.[18]

The methodology employed by AHRQ to define PSIs can be applied to administrative data maintained by most States. The use of ICD-9-CM diagnosis and procedure codes from administrative data to identify potential adverse events may lead to incomplete or inaccurate ascertainment of events, as acknowledged by AHRQ, but they represent a convenient and easy-to-implement method for estimating the prevalence of numerous important complications that occur during inpatient admissions.

In New York during 2001, 3,858 instances of hospital-level cases of Infection Due to Medical Care were identified. New York's rate of 2.02 per 1,000 surgical discharges is similar to recently published estimates using the AHRQ PSIs. Romano et al. established a Selected Infections Due to Medical Care rate of 1.93 per 1,000 using data from the 2000 Nationwide Inpatient Sample.[19]

In New York during 2001, an additional 950 patients with a principal diagnosis of Selected Infections Due to Medical Care were found among those who were readmitted to hospitals within 30 days of a previous inpatient hospital admission. The addition of 950 cases increases the hospital-level AHRQ PSI-based estimate of 3,858 cases of Selected Infections Due to Medical Care in New York State by 25 percent, and increases the rate of this complication from 2.02

per 1,000 surgical discharges to 2.52 per 1,000 surgical discharges. The cases captured by the hospital-level PSI and the readmissions represent patients who received their care in the inpatient setting and developed an infection due to medical care.

To determine if mortality and morbidity of the patients captured by the hospital-level PSI differ from readmitted patients, we examined rates of infections and death for these two groups. We also compared the rates of outcomes in the hospital-level PSI patients and hospital-level patients combined with readmitted patients. When mortality and morbidity of patients captured by the PSI are compared to patients identified upon readmission, there are notable differences. PSI patients have a much higher mortality than readmitted patients do. Patients who met the AHRQ definition for Selected Infections Due to Medical Care were nearly 2.5 times more likely to die as patients readmitted with Selected Infections Due to Medical Care (15.7 percent and 6.3 percent, respectively; see Table 3). This increase in mortality is likely attributable in part to complications of intravenous lines and catheters, but may also be due to other serious comorbidities and complications suffered by the PSI patient. Based on mortality, the current PSI is capturing the patients with the most serious outcomes who are affected by complications of intravenous lines and catheters. The addition of the readmitted patients to the PSI decreases the mortality rate by nearly 30 percent, from 15.7 percent for hospital-level patients to 11.0 percent for hospital-level and readmitted patients combined. Morbidity associated with complications of intravenous lines and catheters was also examined, and the readmitted patients have nearly the same rate of cellulitis, the same rate of bacteremia, and a higher rate of septicemia as patients captured by the PSI. Clearly, patients not captured by the PSI who are readmitted for Selected Infections Due to Medical Care shortly after an inpatient discharge have substantial morbidity, and it is important to identify and capture these patients to fully understand the burden of intravascular device infections in patients receiving care in the inpatient setting. In particular, the rate of septicemia increases by 5.2 percent when patients who were readmitted are added to the hospital-level patients.

The AHRQ PSI for Selected Infections Due to Medical Care has also been defined as an area indicator, where patients with a primary or secondary diagnosis of Selected Infections Due to Medical Care are identified. The area-level indicator identified 7,373 cases in New York State for 2001 (Table 1). The number of patients captured by the area indicator who were not captured by the hospital-level indicator was 3,515. These patients received medical care that involved insertion of an intravascular device and later entered the hospital for inpatient care. It is not clear in what setting these 3,515 patients received their initial care, and it is reasonable to expect that outpatient or physician offices were the setting for care. Based on our analysis, it appears that 904 of the 3,515 patients (26 percent) captured by the area-level indicator but not captured by the hospital-level PSI had the initial medical care encounter as an inpatient. Therefore, the area-level indicator captured 3,858 hospital-level PSI patients and 904 readmissions for a total of 4,762 inpatient-related occurrences of Selected Infections Due to Medical Care. The remaining area-level indicator cases that

were not in the hospital-level PSI or readmission group is 2,611 outpatient or other ambulatory-care-setting occurrences.

Table 2 indicates that the proportion of patients captured by the hospital-level PSI who were renal dialysis patients is 25 percent. The proportion of renal dialysis patients increased to 55.6 percent for patients in the area-level PSI who were found to be readmissions from a previous inpatient stay. Interestingly, a large proportion (64.7 percent) of the patients captured by the area-level PSI with a principal diagnosis of Selected Infections Due to Medical Care that were not in the hospital-level PSI cases or readmissions from a previous inpatient stay were identified as renal dialysis patients. This indicates that the majority of infections due to medical care cases that originate in the outpatient setting derive from a single group of patients.

We have established that the hospital-level PSI is undercounting cases of infection that originate in the inpatient setting by 25 percent by not capturing patients readmitted with Selected Infections Due to Medical Care. These readmitted patients have a lower mortality but similar rates of infection when compared to hospital-level PSI patients. The addition of these cases leads to a significant decrease in mortality (29.9 percent) and a higher rate of septicemia for patients who received care in the inpatient setting (Table 3). These findings indicate that it is important to identify these patients to attribute associated morbidity and mortality with catheter and intravenous line placement that resulted in infection. We have also shown that the majority of the cases captured by the area-level indicator that are not in the hospital-level PSI are outpatient cases, which are largely attributable to a single patient group, renal dialysis patients.

The methods used to identify readmissions involved using two match criteria. First, medical record number and hospital code were used. This is appropriate in New York SPARCS, where the medical record number for the same patient is maintained over time. Although the system generally follows this policy, there are instances where patients do not end up with the same medical record number over time. We also used the unique patient identifier in combination with the patient's date of birth. This second criteria allowed for the linkage of records for a single individual across hospitals. The results of this match process indicated that 770 patients out of 950 readmissions (81 percent) were readmitted to the same hospital. If the medical record number and hospital identification code can be used to identify all of these cases, then States that do not have a unique identifier could still capture a large portion of their readmissions with these codes alone. Analyzing our results, we found that not all of the patients who were identified as readmissions to the same hospital had the same medical record number. If we restrict the matching of patients across hospital stays to only the medical record number and hospital code, 716 patients were identified as readmissions. This represents 75 percent of the 950 patients that we were able to link using all variables. Therefore, it would seem prudent for States with a medical record number and hospital code in their discharge data to attempt to link patients across admissions. While using these variables does not capture all of the linkages

possible with other variables, it nonetheless captured 75 percent of the readmissions in New York State data for Infections Due to Medical Care.

An additional finding of this analysis is that the current definition for the hospital-level PSI identifies cases that have Selected Infections Due to Medical Care diagnosis codes in the principal and secondary positions. This occurs when a patient has a secondary code for Selected Infections Due to Medical Care that meets the criteria for inclusion in the numerator of the PSI, and the patient also has a principal diagnosis of Selected Infections Due to Medical Care. Because the intent of the hospital-level indicator is to identify cases that occur after admission, these cases should be eliminated from the hospital-level PSI by adding exclusion criteria for diagnosis of selected infections in the principal diagnosis field.

Conclusions

These findings, that the hospital-level PSI undercounts cases of infection, help inform policy on two issues. First, it is important for hospitals and physicians to be aware that even though a patient who has undergone a procedure requiring an intravascular device does not acquire an infection during the index admission, this does not mean the patient is not still at risk. This argues for closer monitoring of patients postdischarge and making patients aware of the symptoms of intravascular device-related infections so they can be treated at the earliest possible time. Second, these findings underscore the need to develop data systems that can track patients across multiple admissions for the purpose of identifying complications that result in short-term readmissions. States with administrative databases similar to New York's SPARCS should develop unique patient identifiers that facilitate tracking patients across multiple admissions. Based on our analysis of cases identified with the Selected Infections Due to Medical Care PSI, in the absence of unique identifiers, 75 percent of the patients who are readmitted for care can be identified using only the medical record number and the hospital identification code.

We look forward to future efforts to identify how existing administrative data systems can be used to identify adverse events as completely and as accurately as possible. This task is critical in the all-important quest to optimize the safety and quality of health care in this country.

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